PATENT APPLICATION TRANSMITTAL LETTER
(Large Entity)

Docket No.
8313

TO THE ASSISTANT COMMISSIONER FOR PATENTS

Transmitted herewith for filing under 35 U.S.C. 111 and 37 C.F.R. 1.53 is the patent application of:

Edward S. Miszcak and Milena Krilic-Andan

For: **ULTRA LOW CARBON METAL-CORE WELD WIRE**

Enclosed are:

- ☒ Certificate of Mailing with Express Mail Mailing Label No. **EI833026206US**
- ☐ **None** sheets of drawings.
- ☐ A certified copy of a application.
- ☒ Declaration ☒ Signed. ☐ Unsigned.
- ☒ Power of Attorney
- ☒ Information Disclosure Statement
- ☐ Preliminary Amendment
- ☒ Other: **$40.00 Assignment Recordation Fee**

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra		Rate	Fee
Total Claims	20	- 20 =	0	x	$18.00	$0.00
Indep. Claims	1	- 3 =	0	x	$78.00	$0.00
Multiple Dependent Claims (check if applicable) ☐						$0.00
					BASIC FEE	$760.00
					TOTAL FILING FEE	$760.00

☒ A check in the amount of **$800.00** to cover the filing fee is enclosed.

☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. **09-0025** as described below. A duplicate copy of this sheet is enclosed.

- ☐ Charge the amount of as filing fee.
- ☒ Credit any overpayment.
- ☒ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: **1-08-99**

Signature

Mark W. Croll
Attorney of Record
Reg. No. 31,098

cc:

P01LARGE/REV06

ULTRA LOW CARBON METAL-CORE WELD WIRE

BACKGROUND OF THE INVENTION

The invention relates generally to metal-core weld wires for gas shielded welding operations, and more particularly to ultra low carbon metal-core weld wires having reduced fume generation.

Metal-core weld wires for gas shielded arc welding are known generally and used widely, predominately in welding operations performed on generally horizontal or level surfaces, also typical of the use for solid weld wires, as opposed to out-of-position welding operations. One metal-core weld wire application, among others, is the manufacture of certain railway cars and components therefor wherein steel is welded in single or multi-pass welding operations. The steel in this exemplary application is typically a 70-80 ~~psi~~ ksi 99/01/06 99/01/08 rated carbon manganese steel approximately one-half inch or so thick. Metal-core weld wires are also used for many other applications.

Metal-core weld wires are used increasingly in applications where solid weld wires were once used predominately. In comparison to solid wires, metal-core wires generally have greater deposition and faster travel speeds, improved arc and heat transfer, improved penetration and side wall fusion, reduced spatter and slag, and produce higher quality weld beads, thereby increasing productivity and reducing costs. The benefits of metal-core wires are attributable generally, and among other factors, to a higher current density concentrated in the sheath, and to a wider arc projection, which results in less weld pool turbulence, thus providing a better weld bead.

One known prior art metal-core weld wire for gas shielded arc welding comprises generally a low carbon steel sheath having between approximately 0.02 % and 0.08 % carbon. The prior art metal-core weld wire has a metal core composition comprising predominately iron powder and other generally non-fluxing metal compounds, for example aluminum, titanium and manganese, wherein the metal-core composition is approximately 18 % of the total weight of the weld wire.

The mechanical properties of the weld deposit produced by metal-core

weld wires depend generally on the composition thereof, for example the carbon content, which are controlled to produce mechanical properties that comply with a particular industry classification, for example that of the American Welding Society (AWS) and the Canadian Standards ~~Authority~~ ASSOCIATION (CSA). 09/01/06 09/01/06 mak

Despite the many benefits of metal-core weld wires discussed above, known prior art metal-core weld wires for gas shielded arc welding operations generally produce substantially more fumes in comparison to solid wires. The fumes originate generally in the form of vapors that form complex oxides in the arc. The increased fume generation characteristic of known prior art metal-core weld wires however potentially limits the more widespread use thereof, especially in operations performed indoors and in poorly ventilated welding environments. Fumes tend to reduce air quality and visibility, and have other disadvantages, which are undesirable.

The inventors of the present invention have recognized generally that carbon in metal-core weld wires is a significant source of fume generation, and that fume generation may be reduced substantially by reducing the carbon content in the steel sheath of the weld wire. The inventors have recognized also that relatively small amounts of carbon, or alloys thereof, or other compositions, may be introduced into the metal-core composition of the weld wire to compensate for any degradation in weld deposit mechanical properties resulting from a reduction in the carbon content of the weld wire steel sheath.

The inventors of the present invention have recognized more particularly that fume generation may be reduced generally by reducing the carbon content in the weld wire sheath, and that relatively small amounts of carbon and other compositions may be added to the metal-core composition to control the mechanical properties of the weld deposit without the attending fume generation otherwise occurring if the carbon originated from the steel sheath. Apparently carbon in the core composition of metal-core weld wires is transferred more efficiently into the weld deposit with relatively low fume generation in comparison to carbon transferred from the sheath.

In the field of flux-core weld wires, it is known generally to reduce fumes

by reducing the carbon content in the steel sheath of the weld wire, as discussed in U.S. Patent No. 5,580,475, issued 3 December 1996, entitled "Flux-Cored Wire for Gas Shield Arc Welding With Low Fume". The prior art XL-71 flux-core weld wire, available from ITW Hobart Brothers, Woodstock, Ontario, for example, has a relatively low carbon sheath having not more than approximately 0.008 % carbon therein, wherein the low carbon sheath is formed about a flux-core composition comprising predominately fluxing compounds, for example ferro-manganese silicon alloy, sodium titanate, silica, aluminum oxides and rutile, among other fluxing agents.

It is also known in the field of flux-core weld wires to add carbon to the flux-core composition to compensate for any degradation in weld deposit mechanical properties otherwise associated with the reduction of the carbon content in the steel sheath. In the prior art XL-71 flux-core weld wire, available from ITW Hobart Brothers, discussed above, carbon is added to the core composition in an amount between approximately 0.0048 % C and approximately 0.0072 % C to compensate for the relatively low carbon content in the sheath. The XL-71 flux-core weld wire with carbon added to the core complies with the AWS A5.20 Standard, E71T-1 classification, and produces a weld deposit that has among other properties a minimum yield strength of 58 ksi, a minimum tensile strength of 70 ksi, a minimum elongation of 22 %, and minimum impact value of 20 ft. lbs.

Flux-core weld wires are characterized generally and distinguished from metal-core weld wires by the inclusion of relatively large amounts of fluxing agents in the flux-core thereof in comparison to metal-core weld wires, which include few or no fluxing agents. Flux-core weld wires are also distinguished from metal-core and solid weld wires by relatively large amounts of slag produced on the weld deposits formed by flux-core weld wires. More particularly, flux-core weld wires tend to produce relatively continuous accumulations of slag on the weld deposit. In contrast, metal-core weld wires having substantially fewer, if any, fluxing agents generally produce at most only occasional slag islands along the weld deposit.

Flux-core weld wires are used predominately in gas shielded arc welding

operations where the workpiece is heavily corroded, since the fluxing agents are good deoxidizers. Flux-core weld wires are also used in operations that require out-of-position welding, since the substantial amounts of slag produced thereby tend to hold or retain the weld deposit on the workpiece until the molten weld pool hardens. In many applications, however, the slag must be removed from the weld deposit, usually at a substantial cost, for example in applications where coatings are applied thereto. Flux-core weld wires generally produce substantially more fumes than metal-core and especially solid weld wires. The relatively large amounts of fumes and slag produced by flux-core weld wires generally limits the use of these wires to the particular applications discussed above. For these and other reasons, flux-core wires are generally not used interchangeably with solid and metal-core weld wires.

The present invention is drawn toward advancements in the art of metal-core weld wires for gas shielded welding operations.

An object of the invention is to provide novel metal-core weld wires for gas shielded welding operations that overcome problems in the art.

Another object of the invention is to provide novel metal-core weld wires for gas shielded welding operations that are economical.

A further object of the invention is to provide novel metal-core weld wires having few and preferably no fluxing agents for gas shielded welding operations, whereby the metal-core weld wire has a relatively low fume generation rate.

A further object of the invention is to provide novel metal-core weld wires for gas shielded welding operations, whereby the metal-core weld wire has a relatively low fume generation rate and produces weld deposits having good mechanical properties.

Still another object of the invention is to provide novel metal-core weld wires for gas shielded welding operations comprising an ultra low carbon steel sheath, for example a steel sheath having not more than approximately 0.008 % carbon, and a metal-core composition having few, and preferably no fluxing agents, so that the weld deposit produced thereby has no more than occasional slag islands formed thereon in

comparison to the relatively continuous slag formations typical of flux-core weld wires.

A more particular object of the invention is to provide novel metal-core weld wires for gas shielded welding operations comprising generally a low carbon steel sheath having a carbon content of not more than approximately 0.008 % C. A metal-core composition of the weld wire has little and preferably no fluxing agents, so that the weld deposit produced thereby has no more than occasional slag islands formed thereon, the metal-core composition has preferably carbon added thereto to improve the mechanical properties of weld deposit produced thereby, and the metal-core composition is between approximately 16 % and approximately 20 % of a total weight of the metal-core weld wire, whereby the metal-core weld wire has a relatively low fume generation rate.

These and other objects, aspects, features and advantages of the present invention will become more fully apparent upon careful consideration of the following Detailed Description of the Invention and the accompanying Drawings, which may be disproportionate for ease of understanding, wherein like structure and steps are referenced generally by corresponding numerals and indicators.

DETAILED DESCRIPTION OF THE INVENTION

The invention is drawn to a metal-core weld wire for gas shielded welding comprising generally a low carbon steel sheath having a carbon (C) content of not more than approximately 0.008 % C, and preferably between approximately 0.003 % C and approximately 0.004 % C, to substantially reduce fumes generated during welding. The ultra-low carbon steel sheath is formed, for example, from a continuous cast steel sheet, killed with restricted aluminum and batch carburized, although other ultra-low carbons steels may be used alternatively.

Reducing the carbon content of the steel sheath of the metal-core weld wire may generally lessen the mechanical properties of the resulting weld deposit

produced thereby, including reduced toughness and reduced impact strength. In one embodiment, therefore, a mechanical property enhancing composition, preferably carbon, is reintroduced, or added, to the metal-core composition to generally increase the mechanical properties of the resulting weld deposit, as may be required to comply with a particular AWS or CSA electrode classification.

In one embodiment, the metal-core composition comprises between approximately 0.0020 % C and approximately 0.0047 % C, and the metal-core composition is between approximately 16 % and approximately 20 % of the total weight of the metal-core weld wire. In another embodiment, the metal-core composition comprises between approximately 0.0025 % C and approximately 0.0046 % C, and the metal-core composition is between approximately 17 % and approximately 19 % of the total weight of the metal-core weld wire. And in yet another embodiment, the metal-core composition comprises between approximately 0.0027 % C and approximately 0.0042 % C, and the metal-core composition is approximately 18 % of the total weight of the metal-core weld wire.

In one exemplary embodiment, the total weight of the metal-core weld wire comprises between approximately 0.005 % C and approximately 0.013 % C. More particularly, the range of carbon in the sheath is between approximately 0.003 % C and not more than approximately 0.008 % C, and the range of carbon in the metal-core is between approximately 0.0019 % C and not more than approximately 0.0047 % C, whereby the total weight of the metal-core weld wire C content is the sum of the carbon in the core and the carbon in the sheath.

The total carbon content of the metal-core weld wire of the present invention is relatively low in comparison to other known metal-core and solid weld wires. The total carbon content of the metal-core weld wire of the present invention is also lower than known low carbon flux-core weld wires, for example the XL-71 flux-core weld wire, available from ITW Hobart Brothers. Yet the ultra low carbon metal-core weld wire of the present invention produces less fumes and unexpectedly produces weld deposits having similar or better mechanical properties than the known metal-

core and solid weld wires as well as the XL-71 flux-core weld wire, as discussed below.

In embodiments of the present invention where carbon is added to the metal-core composition to improve mechanical properties of the weld deposit produced thereby, the total amount of carbon in the weld wire is less than that required, to obtain the same properties, if all or most of the carbon originates from the steel sheath. Carbon is transferred more efficiently to the weld deposit from the metal-core composition than from the steel sheath, and thus the relatively small amounts of carbon added to the metal-core composition in the present invention do not appreciably increase the fume generation rate. In other words, it is more efficient to transfer carbon to the weld deposit form the core than from the sheath. Thus according to the invention, carbon in the sheath is minimized, and any carbon required to satisfy a particular mechanical property requirement is introduced into the weld deposit from the core of the weld wire, thereby minimizing the fume generation rate.

In other embodiments, other elements or compositions may be added to the metal-core composition to control the mechanical properties of the weld deposit, so long as the addition thereof does not substantially increase fume generation. The other property enhancing element or compositions may be used as an alternative to adding carbon to the core composition, or in addition thereto, so that the carbon content added to the core and hence the overall carbon content of the metal-core weld wire is reduced, thus further reducing fume generation while improving the mechanical properties of the weld deposit produced thereby.

The metal-core weld wire of the present invention also comprises preferably at least some manganese (Mn) and silicon (Si). The manganese is a deoxidizer, and tends to increase tensile strength of the weld deposit. The silicon is also a deoxidizer, and provides an improved wetting characteristic, thereby providing improved bead profile. In one embodiment, particularly suitable for welding in a 100 % CO_2 shielding gas, the total weight of the metal-core weld wire comprises between approximately 4.0 % Mn and approximately 4.5 % Mn, and between approximately 2.2 % Si and approximately 2.4 % Si. These exemplary amounts of Mn and Si are not

intended to be limiting, and the amounts thereof may be more or less depending on the particular welding operations. A shielding gas containing argon (Ar) or a mixture thereof with CO_2, for example, generally increases the efficiency of transfer of Mn and Si from the weld wire into the weld deposit. Thus where the shielding gas includes argon, the amounts of these elements, Mn and Si, in the metal-core weld wire may be correspondingly reduced in some proportion to the amount of argon added thereto.

In one embodiment, the steel sheath comprises not less than approximately 0.25 % Mn and not more than approximately 0.50 % Mn, and preferably the steel sheath comprises between approximately 0.35 % Mn and approximately 0.45 % Mn. The balance of Mn in the metal-core weld wire constituting the preferred Mn range discussed above originates from the metal-core composition as discussed below.

The steel sheath also comprises not more than approximately 0.040 % Si, the balance of Si in the metal-core weld wire constituting the preferred Si range discussed above also originates from the metal-core composition as discussed below.

The steel sheath also comprises not more than approximately 0.005 % N, and preferably approximately 0.004 % N. The steel sheath also comprises not more than approximately 0.025 % P, not more than approximately 0.015 % S, and not more than approximately 0.025 % Al. In a preferred embodiment, the sheath comprises approximately 0.370 % Mn, approximately 0.005 % P, approximately 0.009 % S, approximately 0.007 % Si, approximately 0.022 % Al, and approximately 0.003 % N.

The metal-core composition is between approximately 16 % and approximately 20 % of a total weight of the metal-core weld wire, and preferably between approximately 17 % and approximately 19 % of the total weight of the metal-core weld wire, and still more preferably approximately 18 % of the total weight of the metal-core weld wire, but may be somewhat more or less so long as the carbon content of the sheath is not more than approximately 0.008 %, and the total weight of the metal-core weld wire is between approximately 0.005 % C and approximately 0.013 % C in embodiments where the metal-core composition includes carbon.

approximately 12.90 % Fe-Mn-Si and approximately 14.26 % Fe-Mn-Si, between approximately 0.52 % Fe-Ti and approximately 0.58 % Fe-Ti, and the balance Fe powder and trace impurities.

There are preferably little or no fluxing agents in the metal-core composition, so that the weld deposit produced by the metal-core weld wire has no more than occasional slag islands formed thereon in comparison to the relatively continuous slag formations typical of flux-core weld wires.

ULTRA-LOW CARBON METAL-CORE WELD WIRE EXAMPLE

In one exemplary embodiment, the metal-core weld wire of the present invention comprises an ultra-low carbon steel sheath and a metal-core composition, which is between approximately 17 % and approximately 19 % of the total weight of the weld wire.

The steel sheath comprises not more than approximately 0.008 % C, between approximately 0.25 % Mn and approximately 0.50 % Mn, not more than approximately 0.025 % P, not more than approximately 0.015 % S, not more than approximately 0.040 % Si, not more than approximately 0.025 % Al, and between approximately 0.004 and approximately 0.005 % N, wherein the percentages of the sheath composition are based on the total weight of the sheath.

The metal-core composition of the exemplary metal-core weld wire comprises between approximately 1.46 % Fe-Mn and approximately 1.62 % Fe-Mn, between approximately 2.85 % Fe-Si and approximately 3.15% Fe-Si, between approximately 12.90 % Fe-Mn-Si and approximately 14.26 % Fe-Mn-Si, between approximately 0.52 % Fe-Ti and approximately 0.58 % Fe-Ti, and the balance Fe powder and trace impurities.

According to this exemplary metal-core weld wire composition, the carbon content of the metal-core composition is between approximately 0.0025 % C

and approximately 0.0046 % C based on the total weight of the weld wire. The range of carbon in the metal-core composition is calculated based on the Fe-Mn having a carbon content in a range between approximately 1.0 % C and approximately 1.5 % C, and the metal-core weld wire having a metal-core composition that is between approximately 17 % and 18 % of the total weight of the weld wire.

FUME GENERATION DATA

Fume generation rate data for a 1.2 mm diameter metal-core weld wire having the same composition as in the EXAMPLE above is disclosed in the "Fume Data Table" below for various different shielding gas mixtures. The metal-core weld wire complies with the Canadian Standards ~~Authority~~ ASSOCIATION 99/01/06 99/01/06 (CSA) W48.5 standard, E4801C-6-CH classification, which is equivalent to the AWS A5.18 standard, E70C-6 classification.

To generate the data, the welding operations were performed under the following conditions: 28 volts; 300 amps; travel speed 14 inches per minute (ipm); and wire feed speed 497 ipm.

The fume generation rate data (FGR) in the "Fume Data Table" were determined pursuant to AWS F1.2, "Laboratory Method for Measuring Fume Generation rates and Total Fume Emission of Welding and Allied Processes". Thus the fume generation rates below are approximate in compliance with AWS F1.2.

Fume Data Table

Shielding Gas	FGR (gr./min.)
100 % CO_2	~~0.28~~ 0.26 99/01/06 99/01/06
75 % Ar and 25 % CO_2	0.38
82 % Ar and 18 % CO_2	0.34
92 % Ar and ~~0~~8 % CO_2	0.32

WELD DEPOSIT CHEMISTRY EXAMPLE I

The "Weld Deposit Chemistry Table I" below is for a weld deposit chemistry produced by a 1.6 mm diameter metal-core weld wire having the same composition as in the EXAMPLE above in a 100 % CO_2 shielding gas. The metal-core weld wire complies with the Canadian Standards ~~Authority~~ ASSOCIATION 99/01/06 99/10/06 mak (CSA) W48.5 standard, E4801C-6-CH classification, which is equivalent to the AWS A5.18 standard, E70C-6 classification.

Weld Deposit Chemistry Table I		
	WELD DEPOSIT	AWS E70C-6
Yield Strength	69,900 psi	58,000 psi (min.)
Tensile Strength	81,200 psi	70,000 psi (min.)
Elongation	30 %	22 %
Impact (CVNs)	39 ft. lbs.	20 ft. lbs.
C	0.026 %	0.12 % (max.)
Mn	1.48 %	1.75 % (max.)
P	< 0.01%	0.03 % (max.)
S	0.01 %	0.03 % (max.)
Si	0.75 %	0.90 % (max.)
Cu	0.04 %	0.50 % (max.)

The weld deposit also includes trace elements, for example, Cr, Ni, Mo, V and other inevitable trace impurities in compliance with the AWS E70C-6 classification. The additional carbon in the weld deposit is derived from CO_2 in the shielding gas.

WELD DEPOSIT CHEMISTRY EXAMPLE II

The "Weld Deposit Chemistry Table II" below is for a weld deposit

chemistry produced by a 1.6 mm diameter metal-core weld wire having the same composition as in the EXAMPLE above in a 92 % Ar and 8 % CO_2 shielding gas mixture. The metal-core weld wire complies with the Canadian Standards ~~Authority~~ Association (CSA) W48.5 standard, E4801C-6-CH classification, which is equivalent to the AWS A5.18 standard, E70C-6 classification.

Weld Deposit Chemistry Table II		
	WELD DEPOSIT	AWS E70C-6
Yield Strength	71,100 psi	58,000 psi (min.)
Tensile Strength	83,400 psi	70,000 psi (min.)
Elongation	30 %	22 %
Impact (CVNs)	29 ft. lbs.	20 ft. lbs.
C	0.020 %	0.12 % (max.)
Mn	1.69 %	1.75 % (max.)
P	< 0.01%	0.03 % (max.)
S	0.01 %	0.03 % (max.)
Si	0.85 %	0.90 % (max.)
Cu	0.04 %	0.50 % (max.)

The weld deposit also includes trace elements; for example, Cr, Ni, Mo, V and other inevitable trace impurities in compliance with the AWS E70C-6 classification. The additional carbon in the weld deposit is derived apparently from the CO_2 shielding gas.

The mechanical properties of weld deposits produced by the exemplary metal-core weld wire of the present invention are the same as or better than the mechanical properties of weld deposits produced by known prior art metal-core and solid weld wires. Yet the weld wires of the present invention have substantially less carbon and produce substantially fewer fumes than do the known prior art metal-core and solid weld wires.

The mechanical properties of the weld deposits produced by the exemplary metal-core weld wire of the present invention are also the same as or better

than the mechanical properties of weld deposits produced by known low carbon flux-core weld wires, yet the weld wires of the present invention have substantially less carbon than low carbon flux-core weld wires. Compare, for example, the mechanical properties in Tables I and II above with the mechanical properties of the XL-71 low carbon flux-core weld wire produced by ITW Hobart Brothers, having a minimum of 0.0048 % C in the flux-core composition and not more than 0.008 % C in the steel sheath thereof, which produces a weld deposit having a minimum yield strength of 58 ksi, a minimum tensile strength of 70 ksi, a minimum elongation of 22 %, and minimum impact value of 20 ft. lbs. This result is unexpected, since the relatively low carbon content between approximately 0.0025 % C and approximately 0.0046 % C, based on the total weight of the weld wire, in the metal-core composition of the present invention suggests that the mechanical properties of the resulting weld deposit produced thereby should be less than the mechanical properties of weld deposits produced by a low carbon flux-core weld wire having a relatively large amount of carbon added to the flux-core composition thereof. The metal-core weld wires of the present invention also produce substantially fewer fumes than are produced by the low carbon flux-core weld wires.

While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific exemplary embodiments herein. The invention is therefore to be limited not by the exemplary embodiments herein, but by all embodiments within the scope and spirit of the appended claims.

CLAIMS

What is claimed is:

1. A metal-core weld wire for gas shielded welding, comprising:

a low carbon steel sheath having a carbon content of not more than approximately 0.008 % C;

a metal-core composition that is between approximately 16 % and approximately 20 % of a total weight of the metal-core weld wire,

whereby the metal-core weld wire has a relatively reduced fume generation rate.

2. The metal-core weld wire of Claim 1, the steel sheath comprises between approximately 0.003 % C and approximately 0.004 % C.

3. The metal-core weld wire of Claim 1, the total weight of the metal-core weld wire comprises between approximately 0.005 % C and approximately 0.013 % C.

4. The metal-core weld wire of Claim 1, the total weight of the metal-core weld wire comprises between approximately 4.0 % Mn and approximately 4.5 % Mn, and between approximately 2.2 % Si and approximately 2.4 % Si.

5. The metal-core weld wire of Claim 1, the steel sheath comprises between approximately 0.35 % Mn and approximately 0.45 % Mn.

6. The metal-core weld wire of Claim 1, the steel sheath comprises between approximately 0.250 % Mn and approximately 0.500 % Mn, not more than approximately 0.025 % P, not more than approximately 0.015 % S, not more than approximately 0.040 % Si, not more than approximately 0.025 % Al, and not more than approximately 0.005 % N.

7. The metal-core weld wire of Claim 6, the steel sheath comprises approximately 0.370 % Mn, approximately 0.005 % P, approximately 0.009 % S, approximately 0.007 % Si, approximately 0.022 % Al, and approximately 0.003 % N.

8. The metal-core weld wire of Claim 1, the metal-core composition comprises between approximately 0.0020 % C and approximately 0.0047 % C.

9. The metal-core weld wire of Claim 1, the metal-core composition comprises between approximately 1.23 % Fe-Mn and approximately 1.56 % Fe-Mn.

10. The metal-core weld wire of Claim 1, the metal-core composition comprises between approximately 2.40 % Fe-Si and approximately 3.60% Fe-Si, between approximately 10.86 % Fe-Mn-Si and approximately 16.30 % Fe-Mn-Si, between approximately 0.44 % Fe-Ti and approximately 0.66 % Fe-Ti, and the balance Fe powder.

11. The metal-core weld wire of Claim 1, the metal-core composition is between approximately 17 % and approximately 19 % of the total weight of the

metal-core weld wire, the metal-core composition comprises between approximately 0.0025 % C and approximately 0.0046 % C.

12. The metal-core weld wire of Claim 1, the metal-core composition comprises between approximately 17 % and approximately 19 % of a total weight of the metal-core weld wire, and the metal-core composition comprises between approximately 1.46 % Fe-Mn and approximately 1.62 % Fe-Mn.

13. The metal-core weld wire of Claim 12, the metal-core composition comprises between approximately 2.85 % Fe-Si and approximately 3.15% Fe-Si, between approximately 12.90 % Fe-Mn-Si and approximately 14.26 % Fe-Mn-Si, between approximately 0.52 % Fe-Ti and approximately 0.58 % Fe-Ti, and the balance Fe powder.

14. The metal-core weld wire of Claim 12, the steel sheath comprises between approximately 0.250 % Mn and approximately 0.500 % Mn, not more than approximately 0.025 % P, not more than approximately 0.015 % S, not more than approximately 0.040 % Si, not more than approximately 0.025 % Al, and not more than approximately 0.005 % N.

15. The metal-core weld wire of Claim 12, the total weight of the metal-core weld wire, the metal-core composition comprises between approximately 0.0025 % C and approximately 0.0046 % C.

16. The metal-core weld wire of Claim 1, the metal-core composition comprises approximately 18 % of a total weight of the metal-core weld wire, and the metal-core composition comprises approximately 3.00 % Fe-Si, approximately 13.58 % Fe-Mn-Si, approximately 0.55 % Fe-Ti, approximately 1.54 % Fe-Mn, and the balance Fe powder.

17. The metal-core weld wire of Claim 12 having a fume generation rate of approximately 0.26 gm./min. when welding with a 100 % CO_2 shielding gas.

18. The metal-core weld wire of Claim 12 having a fume generation rate of approximately 0.38 gm./min. when welding with a 75 % Ar and 25 % CO_2 shielding gas mixture.

19. The metal-core weld wire of Claim 12 having a fume generation rate of approximately 0.34 gm./min. when welding with an 82 % Ar and 18 % CO_2 shielding gas mixture.

20. The metal-core weld wire of Claim 12 having a fume generation rate of approximately 0.32 gm./min. when welding with an 92 % Ar and 8 % CO_2 shielding gas mixture.

ABSTRACT

A low carbon metal-core weld wires for gas shielded welding operations having a low carbon steel sheath with a carbon content not more than approximately 0.008 % C. A metal-core composition of the weld wire has little and preferably no fluxing agents, so that the weld deposit produced thereby has no more than occasional slag islands formed thereon. The metal-core composition may have carbon added thereto to improve the mechanical properties of weld deposit produced thereby, and the metal-core composition is between approximately 16 % and approximately 20 % of a total weight of the metal-core weld wire. The low carbon metal-core weld wire has a relatively low fume generation rate and produces weld deposits with excellent mechanical properties.

Docket No.
8313

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ULTRA LOW CARBON METAL-CORE WELD WIRE

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on ________________ as United States Application No. or PCT International Application Number ________________

and was amended on ________________ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)

______________________ ______________________
(Application Serial No.) (Filing Date)

______________________ ______________________
(Application Serial No.) (Filing Date)

______________________ ______________________
(Application Serial No.) (Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

______________________ ______________________ ______________________
(Application Serial No.) (Filing Date) (Status) (patented, pending, abandoned)

______________________ ______________________ ______________________
(Application Serial No.) (Filing Date) (Status) (patented, pending, abandoned)

______________________ ______________________ ______________________
(Application Serial No.) (Filing Date) (Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

Mark W. Croll	**Reg. No. 31,098**
Thomas W. Buckman	**Reg. No. 25,756**
John P. O'Brien	**Reg. No. 22,764**
Donald J. Breh	**Reg. No. 30,159**

Send Correspondence to: **Mark W. Croll**
Illinois ToolWorks Inc.
3600 W est Lake Avenue
Glenview, IL 60025

Direct Telephone Calls to: *(name and telephone number)*
Mark W. Croll - (847) 657-4073

Full name of sole or first inventor
Edward S. Miszczak

Sole or first inventor's signature | Date 99/01/06

Residence
95 Chesterfield Avenue, London, Ontario N5Z 3M9

Citizenship
Canadian

Post Office Address
95 Chesterfield Avenue, London, Ontario N5Z 3M9

Full name of second inventor, if any
Milena Krilic-Andan

Second inventor's signature Milena Krilic-Andan | Date 99/01/06

Residence
516 Springbank Avenue, Woodstock, Ontario N4T 1H1

Citizenship
Canadian

Post Office Address
516 Springbank Avenue, Woodstock, Ontario N4T 1H1